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PARALLEL PHOTOGRAPHS OF THE SPECTRA OF  
THE SUN, OF IRON, AND OF IRIDIUM, FROM  
THE LINE (H) TO NEAR THE LINE (D), IN SIX  
SECTIONS. ALSO SEPARATE PHOTOGRAPHS OF  
THE SPECTRUM OF TITANIC IRON ORE, IN SIX  
SECTIONS.

BY

FRANK M<sup>C</sup>CLEAN, M.A.

*Parallel Photographs of the Spectra of the Sun, of Iron, and of Iridium, from the Line (H) to near the Line (D), in six sections. Also separate Photographs of the Spectrum of Titanic Iron Ore, in six sections.* By Frank M'Clean, M.A.

The photographs of the solar and metallic spectra now brought before the Society follow the same scheme as the "Photographs of the red end of the Solar Spectrum," presented by the writer in December 1888.

The division into sections and the scale (approximately) are the same as in Ångström's Normal Solar Spectrum. This plan\* has the advantage of always presenting the spectra in the same familiar divisions, and also of rendering these divisions suitable for direct comparison with Ångström's chart.

The present photographs comprise, in the first place, the first six sections of the solar spectrum numbered I. to VI. Taken along with the seven sections comprised in the "red end of the solar spectrum" previously given, and numbered 7 to 13, they complete the whole visible solar spectrum, from (H) to (A).

The present six sections of the solar spectrum are accompanied by corresponding and parallel photographs of the spectra of metallic iron, and of metallic iridium.

The iridium spectrum was fixed upon in order to obtain a full spark spectrum of air, for purposes of comparison. It shows Kirchhoff's iridium lines at wave-lengths 5299 and 5450. It also shows other unregistered lines, either of iridium or of air, which however can only be identified correctly when photographs of further spectra have been obtained. The air lines are present, more or less distinctly, in all spark spectra taken in air, and they supply a ready and accurate means of co-ordinating such spectra with the iron spectrum and with each other.

The iron spectrum was fixed upon on account of its close correspondence throughout with the spectrum of the Sun, and its thus furnishing the best means of co-ordinating the spectra of the other metals with the solar spectrum. The reference of the metallic spectra to the scale of wave-lengths established by Ångström's Normal Solar Spectrum is thus obtained, and it should be borne in mind that Ångström's spectrum is the only complete spectrum of any kind which has been determined to the scale of wave-lengths by direct observation.

It should be remembered that the photographs are only suitable for filling in the details of the spectra between the standard reference lines. Neither the spectroscope used nor the photographic impression is suitable for the accurate measurement of the angle of divergence between the standard lines themselves. A much more compact spectroscope with graduations and adjustments of the most perfect character would be absolutely necessary for such a purpose. The radical difference between measure-

ments within the field of view and independent measurements of direction is involved. The want of rigidity scarcely avoidable with the long tubes of a spectroscope suitable for photography, although comparatively immaterial in the first case, would be fatal where the observation must be made along the line of collimation of the telescope and the direction accurately determined.

Thalén's determinations of the wave-lengths of the metallic spectra, which accompany Angström's chart, were not made with a diffraction spectroscope. They were, in fact, Kirchhoff's and Hofmann's determinations of the metallic spectra, and were made with a refraction spectroscope to "Kirchhoff's scale." Thalén transformed them to wave-lengths by means of interpolation, on a curve drawn through a large number of points, whose abscissæ represented the wave-lengths of the lines of Angström's solar spectrum.

Dr. Huggins' determinations of the "Spectra of the Chemical Elements" were also made with a refraction spectroscope. He proceeded by referring the observed spectrum to the lines of the air spectrum as lines of reference. The measurements were taken to the graduated scale of his own instrument. He determined the position of the principal lines of the solar spectrum to the same scale, but, being foreign to his purpose, he did not establish any more detailed connection between the spectra of the chemical elements and the solar spectrum. There seems, therefore, to be an opportunity for the co-ordination of the metallic spectra, by means of the direct comparison of photographs taken with the diffraction spectroscope, with Angström's standard wave-length chart of the solar spectrum. The writer purposes, if possible, to continue the present series of photographs of the metallic spectra with this object in view.

The striking coincidence of the spectrum of iron with the solar spectrum is of course well known. But to many it is only hearsay knowledge. The present photographs display it to the eye itself, and they carry with them a conviction due to their being the self-recorded images of the phenomena themselves. Attention may be directed to Section V. as particularly rich in coincidences, including the double (E) line with components under one tenth-metre apart. The curious double character of nearly all lines at the violet end of the spectrum is shown in Sections I. and II., although on reaching (H) the definition of the spectroscope somewhat fails.

The same six sections of photographs of the spectrum taken between electrodes of iron and ilmenite (or titanite iron ore), mounted on loose slips, accompany the bound photographs, in order to illustrate the way in which the photographs can be compared with each other, and with Angström's chart. If Section IV. of these slips be compared with Angström's, the presence in the titanite iron ore, of titanium, chromium, cobalt, and calcium, is at once apparent. Magnesium and barium are also

shown by other sections. The same specimen of ore has unfortunately not been used for all the sections.

It is hoped eventually to extend the metallic spectra to three further sections, thus including the Fraunhofer line (C). But as this must be a much more laborious undertaking it has been for the present postponed.

As before, the photographs have been taken with a Rutherford grating ruled 17,296 lines to the inch, and about  $1\frac{3}{4}$  inch square, and they have been enlarged from the original negative about  $8\frac{1}{2}$  times.

The writer is unaware of any photographs of the metallic spectra, below the (H) group of lines in the violet, having hitherto been produced to the large scale of the present photographs.

The photographs which accompany the Paper have been placed in the Library.









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